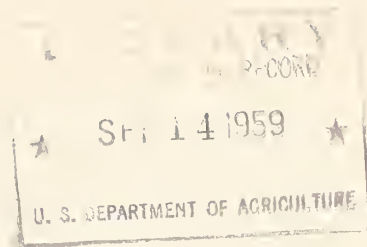


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Control of Wind Erosion in the Sandy Lands of the Southern High Plains of Texas and New Mexico

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CONTROL OF WIND EROSION IN THE SANDY LANDS OF THE SOUTHERN HIGH PLAINS OF TEXAS AND NEW MEXICO

By W. C. Moldenhauer, J. R. Coover, and M. E. Everhart¹

INTRODUCTION

Wind erosion occurs when high winds come in contact with loose, unprotected soil. Particles of medium and fine sand begin to move across the soil surface in a series of bounces or by rolling or creeping. Where they strike unprotected soil they loosen other particles which are then swept across the ground surface and cause still further erosion. Finer particles are sometimes carried high into the air and may float for days before settling.

The damage done by wind erosion has serious short- and long-term effects. The most notable short-term effect is that of reducing or eliminating stands of crops. One storm can completely destroy young cotton. A visible effect of erosion is the piling up of sand or silt on highways, railroad rights-of-way, and around buildings on farms and in urban areas. This material must be removed at great expense. Another visible effect of wind erosion is the duning of sand in cultivated fields, making them impractical to till for crop production. Perhaps the most serious effect of wind erosion, however, is seldom noticed. This is the removal of clay and organic matter from sandy soils. The soil is left not merely more susceptible to wind erosion than before; the materials which are of major importance in storing and eventually releasing moisture and nutrients are gone from the plowed layer. The finer the texture, the more serious the loss, since organic matter (thus nitrogen) is stored in the surface 6 or 7 inches of the soil. Removal of a part or all of this horizon usually reduces the inherent productivity of the soil.

Protecting the soil from wind erosion may be accomplished, at least to some extent, by any one of three methods or by combination of them: (1) Residue cover to protect the soil surface, (2) surface roughness to restrict the movement of wind and eroding materials, and (3) soil cloddiness. Residue cover such as small grain or sorghum stubble protects the soil by reducing the wind velocity near the surface. Surface roughness reduces the effective contact between erosive wind and the soil surface and causes the first few moving soil particles to be trapped. Soil clods present a form of surface roughness, and at the same time reduce susceptibility to wind erosion because the particles at the surface are too large to be moved by wind. Soil clods are formed by clay and organic matter binding the sand and silt particles together. The amount of erosion depends on the stability and number of clods, which should be no smaller than about the size of alfalfa seed; larger clods increase wind resistance even more.

The susceptibility to wind erosion of prevalent soils in the Southern High Plains of Texas and New Mexico was determined by the method of Chepil, Woodruff, and Zingg (1955).² For purposes of information and identification, pictures of vegetation on each soil type, along with a list of range plants which grow under climax conditions and a companion list showing changes in vegetation as the condition of the range deteriorated, are included. Also included are data on mineral contents and crop yields of each soil type and discussion of their significance.

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² Chepil, W. S., Woodruff, N. P., and Zingg, A. W., Field Study of Wind Erosion in Western Texas. U. S. Dept. Agr., Soil Conserv. Serv. TP-125, 60 pp. 1955.

COMPARATIVE ERODIBILITY OF SOUTHERN HIGH PLAINS SOILS AND AMOUNT OF COVER NEEDED TO PROTECT THEM

Comparative erodibility of the major soils of the Southern High Plains and the amounts of cover necessary to protect them under range and cultivated conditions are given in table 1. The Amarillo and Portales fine sandy loams are 15 to 30 times more erosive than the Amarillo clay loam. The Brownfield fine sand and loamy fine sand are 10 to 40 times more erosive, and Tivoli and Springer soils are 50 to 270 times more erosive, than the Portales and Amarillo fine sandy loams.

Residue weights in table 1 are air-dry weights of stubble undisturbed after harvest. The amounts necessary for complete protection will vary depending on the type of vegetation, its height, density, and uniformity, and whether it is flattened or standing. These residue weights were calculated from RK values required to keep erosion below 0.25 ton per acre and refer to stubble undisturbed after harvest.

It will be noted that for the Tivoli, Springer, and Brownfield soils more residue is needed on the newly broken areas than on the rangeland. For the Portales and Amarillo soils the opposite is true. Under native shrubs and grasses the sandier soils are partially protected by a surface crust or mat of fine roots and by accumulations of finer material deposited by wind. With the finer textured soils, the material accumulated by wind deposition is coarser than the natural soil texture.

TABLE 1.--Comparative erodibility of Southern High Plains soils and the amount of cover necessary to protect them from wind erosion under range and cultivated conditions

Soil type	Soil unit ¹	Maximum soil loss on newly broken land under a sustained wind (38 miles per hr.) with no roughness or cover	Weight of standing stubble required to keep erosion below 0.25 ton per acre	
			Newly broken land	Rangeland
		<i>Tons per acre</i>	<i>Lb. per acre</i>	<i>Lb. per acre</i>
Tivoli fine sand.....	13	1,600	over 3,000	2,000
Springer fine sand...	12X	650	2,500	1,750
Brownfield fine sand.	12	240	1,600	1,400
Brownfield loamy fine sand.....	L12	150	1,400	1,200
Portales fine sandy loam.....	7X0	12	440	780
Amarillo fine sandy loam.....	70	6	370	600
Amarillo clay loam ² ..	2	0.4	100	410

¹ Soil unit terms used by Soil Conservation Service in the High Plains area.

² This soil has been included in the Amarillo series in the past but is subject to recorrelation into another series. It is not known to occur in New Mexico.

In order to determine differences in erodibility of the newly broken land of table 1 and that under cultivation for a number of years, the values were compared with those obtained by Chepil, Woodruff, and Zingg on soils of the same type. Erodibility of the surface inch of Amarillo fine sandy loam under long-term cultivation was found by these workers to be much higher than the values obtained in the present study for undisturbed rangeland. Erodibility of the 1- to 6-inch horizon, however, was found by Chepil, Woodruff, and Zingg to be considerably lower under long-term cultivation than it was on rangeland as determined by the present study. This may be the result of erosion which put the 1- to 6-inch horizon deeper into the profile in the old cultivated land. It could be

due also to the presence of clods formed from compaction by tillage and from the presence of finer textured materials brought up from below by chisels and plows. For Brownfield loamy fine sand the surface inch of soil plowed 14 inches or deeper was about as erodible as that reported for untilled rangeland, but the 1- to 14-inch horizon was much less erodible in this deep-plowed soil. Erodiability of the Portales fine sandy loam did not appear to change a great deal under cultivation. Portales soils contain free lime, which makes them more erodible than Amarillo soils of like texture. Tivoli soils are coarser textured than Springer soils and are uniformly coarse textured throughout the profile.

FERTILITY OF SOILS OF THE SOUTHERN HIGH PLAINS

In any area where crop yield is most often regulated by the amount and distribution of rainfall, fertility becomes of secondary importance. During years of low or even average rainfall, soils of very low fertility, such as Brownfield and Springer soils, will produce as much or even more than the more fertile Amarillo and Portales soils. Use of commercial fertilizers must be much better understood before they can be recommended for correcting low fertility under these conditions.

Crops on the sandiest soils respond much more to small summer showers than do those on the clay loams or even the fine sandy loams. A 1-inch shower will wet a clay loam soil to a depth of 6 inches, or less if the soil is dry. About half of this will be lost rapidly through evaporation. On a fine sand a 1-inch rain will penetrate 2 feet or more with less than one-fourth being lost to evaporation. Thus in arid regions higher yields are often obtained during years of low seasonal rainfall on the sandier soils even though the fertility is much lower (table 2).

TABLE 2.--The organic matter, phosphorus, and potassium contents of virgin soil types of the Southern High Plains of Texas

Soil type	Soil unit	Organic matter		Phosphoric acid (P ₂ O ₅)		Potash (K ₂ O)	
		Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil
Tivoli fine sand..	13	Very low	Very low	Very low	Very low	Very low	Very low
Springer fine sand	12X	Very low	Very low	Very low	Very low	Low	Very low
Brownfield fine sand.....	12	Low	Very low	Very low	Very low	Low medium	Medium
Brownfield loamy fine sand.....	L12	Low	Very low	Very low	Very low	High	High
Portales fine sandy loam.....	7X0	Low medium	Low medium	Low	Low	High	High
Amarillo fine sandy loam.....	70	Low medium	Low medium	Low	Very low	High	High
Amarillo clay loam	2	Low	Low	Low	Very low	High	High

TABLE 2.--The organic matter, phosphorus, and potassium contents of virgin soil types of the Southern High Plains of Texas--Continued

Explanation of soil-test readings ¹				
Reading	Organic matter in surface soil		Phosphoric acid ² (P ₂ O ₅)	Potash (K ₂ O)
	Sands	Clays		
	<i>Pct.</i>	<i>Pct.</i>	<i>Lb. per acre</i>	<i>Lb. per acre</i>
Very low.....	Up to 0.5	Up to 1.0	Up to 20	Up to 100
Low.....	0.51 - 0.75	1.01 - 1.5	21 - 40	101 - 150
Low medium.....	0.76 - 1.25	1.51 - 2.25	41 - 60	151 - 200
Medium.....	1.26 - 1.75	2.26 - 3.0	61 - 80	201 - 300
High.....	Over 1.75	Over 3.0	Over 80	Over 300
	Organic matter is approximately 1/20 nitrogen			

¹ Data from Thornton, M. K., and Caldwell, A. G., Explanation of Soil Tests. Tex. Agr. Ext. Serv. ST-4: 2 pp. [n.d.]

² Ammonium acetate method used on both A and B horizons.

As an illustration of this point, in 1954 at Big Spring, Tex., yields of grain were 480, 550, and 900 pounds per acre, respectively, for the Brownfield loamy fine sand, Brownfield fine sand, and Springer fine sand. This shows the advantage of the coarser texture, in a year of low seasonal rainfall. The disadvantage of the coarser texture is evident, however, from table 1, in which is shown the comparative wind erodibility of the Brownfield and Springer soils. Establishing a crop without severe loss of stand is a real problem every year on these two soils.

CHARACTERISTICS OF THE PREVALENT SOIL TYPES OF THE SOUTHERN HIGH PLAINS

This section presents the important characteristics for each of the prevalent soil types of the Southern High Plains. Each type is illustrated, and the range plants each can support under climax and under deteriorated conditions are listed. The lists of range plants and the illustrations may prove helpful in identification of the various soil types. The capability class is included with the soil-type name. Best land use is indicated for each soil type according to the present knowledge of its capabilities. It must be understood that each discussion in this section assumes a dryland condition.

Tivoli Fine Sand

Capability Class - VII

Native vegetation:

Original (climax) vegetation. --Shinnery (Havard Oak) and Yucca (Soapweed) were present, along with tall and mid grasses and a few short grasses. The grasses were dominant and kept the Shinnery and Yucca from spreading. Tall grasses were sand bluestem, Indiangrass, switchgrass, giant dropseed and big sand reed. Mid grasses were little bluestem, side-oats grama, perennial threeawns, hooded windmillgrass, mesa dropseed, and sand dropseed. Short grasses were hairy grama and fall witchgrass.

Deteriorated range. --Shinnery (Havard Oak) and Yucca (Soapweed) have spread over most of the ground area and have become dominant. There has been an increase in perennial threeawns, hooded windmillgrass, mesa dropseed, and hairy grama. The following vegetation has invaded the site: Red lovegrass, gummy lovegrass, fringed signalgrass, cactus, and many annual forbs and grasses (Figure 1).



Figure 1. --Tivoli fine sand. Capability class - VII.

Erodibility:

Tivoli fine sand is a deep soil with no heavier subsoil or "clay" to a depth of many feet. It is highly erodible and very low in fertility. It is entirely unsuitable for tillage because of its high erodibility. As much as 400 tons per acre of this soil when devoid of cover could be lost during a sustained high wind, and once the surface mat of roots and other organic material is destroyed, as high as 1,600 tons per acre could be lost, as reported here (see table 1). Deep plowing of this soil is completely ineffective, because it becomes more erodible with depth. Cover is the only effective means of preventing wind erosion. Since this soil will erode continuously if it is tilled, establishing cover on it is almost impossible. Consequently, the present native vegetation affords the most reliable protection and the best land use.

Springer Fine Sand

Capability Class - VI

Native vegetation:

Original (climax) vegetation. --Small amounts of Shinnery (Havard Oak) and Yucca (Soapweed) were present along with mid grasses and a few tall and short grasses. The grasses were dominant and held the Shinnery and Yucca from spreading. The mid grasses were little bluestem, side-oats grama, Plains bristlegrass, hooded windmillgrass, perennial threeawns, mesa dropseed, and sand dropseed. The tall grass present was sand bluestem. The short grasses were hairy grama and fall witchgrass.

Deteriorated range. --Shinnery (Havard Oak) and Yucca (Soapweed) have spread over most of the ground area and have become dominant. There has been an increase in perennial threeawns, hooded windmillgrass, mesa dropseed, sand dropseed, and hairy grama. The following vegetation has invaded the site: Gummy lovegrass, fringed signalgrass, cactus, many annual forbs and grasses, and an occasional mesquite (Figure 2).



Figure 2. --Springer fine sand. Capability class - VI.

Erodibility:

Springer fine sand is a deep soil with a weakly developed sandy loam subsoil at a depth of 24 to 36 inches. It is highly erodible and very low in fertility. Although less erosive than Tivoli fine sand below the surface crust, it is too erosive for safe cultivation.

It would be possible to lose as much as 300 tons per acre of this soil during a sustained high wind if there were no residue cover on it; once the surface mat of organic cemented material is destroyed, 650 tons per acre could be lost (see table 1). Deep plowing of this soil for wind-erosion control is ineffective because the subsoil is only slightly less erodible than is the surface.³ The fertility of the subsoil is somewhat less than that of the upper 9 inches of soil. Since this soil erodes continuously when it is tilled, it is very difficult to get a crop established. Where it has been tilled, it is characterized by large "blowout spots" and dunes. The only completely satisfactory protection for this soil is some type of perennial vegetation.

Brownfield Fine Sand

Capability Class - VI

Native vegetation:

Original (climax) vegetation. --Mid grasses predominated and there were few if any woody shrubs found on this site. The mid grasses were little bluestem, side-oats grama, Plains bristleggrass, hooded windmillgrass, perennial threeawns, mesa dropseed, and sand dropseed.

Deteriorated range. --There has been an increase in perennial threeawns, hooded windmillgrass, mesa dropseed, and sand dropseed. The following vegetation has invaded the site: Shinnery (Havard Oak), Yucca (Soapweed), fringed signalgrass, gummy love-grass, cactus, mesquite, and many annual forbs and grasses (Figure 3).

Erodibility:

Brownfield fine sand is a deep soil with a moderately permeable, red, sandy clay loam subsoil at 20 to 30 inches. It is highly erodible and very low in fertility. Although not quite as erodible as Springer fine sand, it is too erodible for safe cultivation with present farming methods. It would be possible to lose 150 to 240 tons per acre of this soil during a sustained high wind if it were devoid of residue cover (see table 1). Clods are unstable in this soil and they disintegrate rapidly when subjected to abrasion from surrounding "blowout spots." This fact makes emergency tillage a very temporary practice for wind-erosion control. Deep plowing of this soil is ineffective in controlling wind erosion, because the soil material brought up by the plow is only slightly less erodible than is the surface. Deep plowing to increase productivity is ineffective, because this soil becomes less fertile with depth. The only completely satisfactory protection for this soil is some type of perennial vegetation.

³ The assumption is made that plowing more than 24 inches deep is not practical because of high cost. The soil material within 24 inches of the surface will not change the texture of the surface soil greatly when the soil is plowed to this depth.



Figure 3. --Brownfield fine sand. Capability class - VI.

Brownfield Loamy Fine Sand

Capability Class - IV

Native vegetation:

Original (climax) vegetation. --Mid grasses predominated and there were very few if any woody shrubs found on this site. The mid grasses were little bluestem, side-oats grama, Plains bristlegrass, hooded windmillgrass, Arizona cottontop, and perennial threeawns.

Deteriorated range. --There has been an increase in perennial threeawns and hooded windmillgrass. The following vegetation has invaded the site: Fringed signalgrass, sand dropseed, mesa dropseed, gummy lovegrass, cactus, mesquite, catclaw, sand muhly, annual forbs and grasses, and small amounts of Shinnery (Havard Oak) and Yucca (Soapweed) (Figure 4).

Erodibility:

Brownfield loamy fine sand has a moderately permeable, red, sandy clay loam subsoil at less than 18 inches below the surface. It is highly erodible and very low in fertility. Because of the fact that it has a comparatively erosion-resistant subsoil, it is suitable for limited cultivation if deep plowed and if certain precautions are taken.



Figure 4. --Brownfield loamy fine sand. Capability class - IV.

Before deep plowing this soil is almost as erodible as Brownfield fine sand. It would be possible before deep plowing to lose between 110 and 150 tons per acre of this soil during a sustained high wind if no residue cover were present (see table 1). Clods in this soil before deep plowing are very unstable. They disintegrate rapidly when subjected to abrasion by shifting sand from surrounding "blowout spots", making emergency tillage an ineffective practice for wind-erosion control. When this soil has been eroded to the subsoil, it becomes useless for cultivation and very difficult to return to perennial vegetation. This is the only soil of the loamy sand and sand textures on which the wind-erosion hazard can be reduced appreciably by deep plowing. After deep plowing, however, it will again become very sandy and highly erodible if not protected, or if it becomes covered by drifting sand from nearby untreated areas.

Portales Fine Sandy Loam

Capability Class - III

Native vegetation:

Original (climax) vegetation. --Mid grasses predominated with small amounts of short grasses. Mid grasses were side-oats grama, Plains bristlegrass, silver and cane bluestem, hooded windmillgrass, sand dropseed, Arizona cottontop, and black grama.

Deteriorated range. --There has been an increase in sand dropseed, black grama, and hooded windmillgrass. The following vegetation has invaded the site: Mesquite, cactus, catclaw, bristle panicum, perennial threeawns, and many annual forbs and grasses (Figure 5).



Figure 5. --Portales fine sandy loam. Capability class - III.

Erodibility:

This soil is a brown, fine sandy loam with porous, sandy clay loam subsoil at about 10 inches below the surface. Free lime occurs throughout the soil. It is a moderately erodible soil of low to medium fertility and, with Amarillo fine sandy loam, is one of the better agricultural soils in the Southern High Plains area. Under cultivation, soil cloddiness can be used to help control wind erosion. This soil is less erosive in the native state in the 1- to 6-inch layer than in the 1-inch surface layer, which is not the case with Tivoli, Springer, and Brownfield soils. The latter three are more erosive below than at the surface under range conditions. While clods in the Portales soil are much more stable than in the previously described soils, they will break down readily during a rain or when subjected to abrasion by shifting sand. When the clods are subject to erosion with no residue cover present, emergency tillage must be used to control erosion. Since emergency tillage is effective only when the soil is moist, this practice does no good during dry periods. It is much more satisfactory to combine surface roughness and residue cover for complete protection. It would be possible to lose between 12 and 40 tons of this soil during a sustained high wind if no surface roughness or cover were present (see table 1).

Amarillo Fine Sandy Loam

Capability Class - III

Native vegetation:

Original (climax) vegetation. --Mid grasses and short grasses grew in about equal proportions on this soil type. Mid grasses present were side-oats grama, silver and cane bluestem, Arizona cottontop, and sand dropseed. Short grasses present were blue grama, buffalograss, and vine mesquite.

Deteriorated range. --There has been an increase in buffalograss and sand dropseed. The following vegetation has invaded the site: Mesquite, cactus, broom snakeweed, perennial threeawns, and many annual forbs and grasses (Figure 6).



Figure 6. --Amarillo fine sandy loam. Capability class - III.

Erodibility:

This soil is a brown, fine sandy loam with a reddish brown, moderately permeable sandy clay loam subsoil at about 10 inches below the surface. It is moderately erodible soil, is moderately low in fertility, and is one of the better agricultural soils in the Southern High Plains area. With this soil, as with the Portales fine sandy loam, cloddiness can be used to help control wind erosion. This soil also is less erosive in the native state below the first inch than it is in the surface inch. As with the Portales fine sandy loam, clods in this soil break down during a rain or when subjected to abrasion by

blowing sand. When the clods are unprotected, emergency tillage is required to control erosion. But tillage is effective only when the soil is moist. Consequently it is much more satisfactory to combine roughness and residue cover for complete protection. It would be possible to lose between 6 and 20 tons of this soil under a sustained high wind if no surface roughness or cover were present (see table 1).

Amarillo Clay Loam⁴

Capability Class - II

Native vegetation:

Original (climax) vegetation. --Short grasses predominated with small amounts of mid grasses. Short grasses were blue grama, buffalograss, vine mesquite, and tobosa. Mid grasses present were side-oats grama, silver and cane bluestem, Arizona cotton-top, and sand dropseed.

Deteriorated range. --There has been an increase in tobosa and buffalograss. The following vegetation has invaded the site: Mesquite, cactus, perennial threeawns, and many forbs and grasses (Figure 7).



Figure 7. --Amarillo clay loam, Capability class - II.

⁴ This soil has been included in the Amarillo series in the past but is subject to recorelation into another series. It is not known to occur in New Mexico.

Erodibility:

This soil has about 6 inches of dark grayish brown clay loam surface soil which rests abruptly on a dense, slowly permeable, blocky clay subsoil. This soil constitutes the "hardlands" of the Southern High Plains, and is included here for comparative purposes. It is slightly erosive and low to medium in fertility. It is not in the class of the previously discussed soils from the standpoint of wind erosion, because clods are quite stable and emergency tillage can be used to control erosion. It should be pointed out that erosion is much more harmful to this soil than to some soils because crops depend on the surface 6 or 8 inches for a large part of their nutrients. The loss of any of this surface soil reduces the fertility of the soil greatly and should be avoided. For this reason residue cover should be used if at all possible, for more effective protection against wind erosion.

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